

# PATENT COOPERATION TREATY

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner  
US Department of Commerce  
United States Patent and Trademark  
Office, PCT  
2011 South Clark Place Room  
CP2/5C24  
Arlington, VA 22202  
ETATS-UNIS D'AMERIQUE  
in its capacity as elected Office

Date of mailing (day/month/year) 15 May 2001 (15.05.01)	Applicant's or agent's file reference 29317WOP00
International application No. PCT/AU00/01029	Priority date (day/month/year) 30 August 1999 (30.08.99)
International filing date (day/month/year) 30 August 2000 (30.08.00)	
Applicant PAUL, George, Lange et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:  
06 March 2001 (06.03.01)

☐ in a notice effecting later election filed with the International Bureau on:  
\_\_\_\_\_

2. The election ☒ was  
☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Charlotte ENGER
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

Form PCT/IB/331 (July 1992)

AU0001029

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>29317wo</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/AU00/01029</b>	International filing date ( <i>day/month/year</i> ) <b>30 August 2000</b>	(Earliest) Priority Date ( <i>day/month/year</i> ) <b>30 August 1999</b>
Applicant <b>ENERGY STORAGE SYSTEMS PTY LTD et al</b>		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 6 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

#### 1. Basis of the report

a. With regard to the language, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ Certain claims were found unsearchable (See Box I).

3. ☒ Unity of invention is lacking (See Box II).

4. With regard to the title, ☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the abstract, ☒ the text is approved as submitted by the applicant

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the drawings to be published with the abstract is Figure No. 1

☒ as suggested by the applicant.

☐ None of the figures

☐ because the applicant failed to suggest a figure

☐ because this figure better characterizes the invention

**Box I** Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos :  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos :  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box II** Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See supplemental sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims  
☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.

## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/AU00/01029**A. CLASSIFICATION OF SUBJECT MATTER**Int. Cl. <sup>7</sup>: H01G 9/004, 9/02, 9/08, H01M 2/14, 2/18

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

IPC: H01G, H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI, JAPIO

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5445856 A (CHALONER-GILL) 29 August 1995 Cols 3, 4	26, 31
X	US 4628011 A (FELDMAN et al) 9 December 1986 Col 1 lines 27-29; col 3 lines 24-68	26, 27, 31-33, 39-46
X	US 4218519 A (FRANK) 19 August 1980 Cols 3, 4	26, 27

☒ Further documents are listed in the continuation of Box C ☒ See patent family annex

* : Special categories of cited documents:	"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier application or patent but published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  
10 November 2000Date of mailing of the international search report  
15 NOV 2000Name and mailing address of the ISA/AU  
AUSTRALIAN PATENT OFFICE  
PO BOX 200, WODEN ACT 2606, AUSTRALIA  
E-mail address: pct@ipaustalia.gov.au  
Facsimile No. (02) 6285 3929Authorized officer  
  
M.E. DIXON  
Telephone No : (02) 6283

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 224932 A (HITACHI, LTD) 10 June 1987 Page 10 line 22 - page 13 line 16	1, 17, 24, 26, 31
X	Derwent Abstract Accession No. 90-003392/01, Class X16, JP 01-286262 A (NIPPON TELEG & TELEPH) 17 November 1989 abstract	1, 13, 24-26
X	Derwent Abstract Accession No. 86-276709/42, Class X16, JP 61-203575 A (HITACHI KK) 9 September 1986 abstract	24
A	EP 386305 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD) 12 September 1990 page 2 lines 46-53	14
X	US 5926362 A (MUFFOLETTO et al) 20 July 1999 Col 2 lines 38-53; col 3 lines 6-23; col 5 lines 43-46; figs 1-3	47-53, 58-63
X	US 5601946 A (HATTORI et al) 11 February 1997 Col 4 lines 22-67; fig 1	47-53, 58-63
X	US 5450279 A (YOSHIDA et al) 12 September 1995 Example 1; fig 1	47-63
X	US 4604333 A (IKEDA et al) 5 August 1986 Col 2 line 53 - col 3 line 23; figs 1-6	47-53, 58-63
X	GB 2046019 A (SPRAGUE ELECTRIC COMPANY) 5 November 1980 Whole document	47-63
X	EP 854529 A (MITSUBISHI CABLE INDUSTRIES, LTD) 22 July 1998 Page 7 lines 7-53; figs	47-63
A	US 4948685 A (OHSAWA et al) 14 August 1990 Figs 4-10	47

**Supplemental Box**

(To be used when the space in any of Boxes I to VIII is not sufficient)

**Continuation of Box No: II**

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are two inventions:

1. Claims 1-46 directed to a charge storage device with means for removal of contaminants, its method of construction and a method for removing contaminants therefrom. These claims are characterised by means for sequestering, removing or drawing contaminants from the device and this is considered to comprise a first "special technical feature".
2. Claims 47-63 directed to a charge storage device and method of construction and including terminals, electrolyte and sheet electrodes with a separator enveloping one of the electrodes for maintaining the electrodes in spaced apart configuration. It is considered that a separator enveloping one of the electrodes for maintaining the electrodes in spaced apart configuration comprises a second "special technical feature"

Since the above mentioned groups of claims do not share either of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept.

INTERNATIONAL SEARCH REPORT  
Information on patent family members

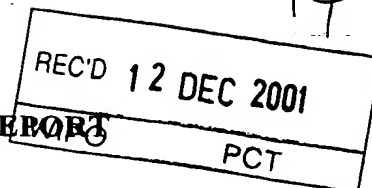
International application No.  
PCT/AU00/01029

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report				Patent Family Member			
US	5445856	AU	11732/95	WO	9513629		
US	4628011	CA	1189684				
US	4218519	NONE					
EP	224932	JP	62133679				
EP	386305	US	5034289	US	5250369	US	5346781
		JP	2291665				
US	5926362	AU	63818/98	EP	877400	JP	10312936
US	5601946	EP	657952	JP	7161377		
US	5450279	EP	625787	JP	7094374		
US	4604333	JP	59176886				
GB	2046019	CA	1136232	JP	55133531	US	4267566
EP	854529	CA	2223370	JP	10172607	JP	10172608
		JP	10172565				
US	4948685	—	DE	3829541	JP	2168560	JP
		1067863	US	4999263	WO	8808210	
END OF ANNEX							

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**TENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY EXAMINATION REPORT**  
(PCT Article 36 and Rule 70)



Applicant's or agent's file reference 29317wo	<b>FOR FURTHER ACTION</b>	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. <b>PCT/AU00/01029</b>	International Filing Date (day/month/year) 30 August 2000	Priority Date (day/month/year) 30 August 1999
International Patent Classification (IPC) or national classification and IPC Int. Cl. <sup>7</sup> H01G 9/004, 9/02, 9/08, H01M 2/14, 2/18		
Applicant ENERGY STORAGE SYSTEMS PTY LTD et al		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheet(s).

3. This report contains indications relating to the following items:

I	<input checked="" type="checkbox"/>	Basis of the report
II	<input type="checkbox"/>	Priority
III	<input type="checkbox"/>	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	<input checked="" type="checkbox"/>	Lack of unity of invention
V	<input checked="" type="checkbox"/>	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	<input type="checkbox"/>	Certain documents cited
VII	<input type="checkbox"/>	Certain defects in the international application
VIII	<input checked="" type="checkbox"/>	Certain observations on the international application

Date of submission of the demand 6 March 2001	Date of completion of the report 28 November 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  <b>M.E. DIXON</b> Telephone No. (02) 6283 2194



**I. Basis of the report**

1. With regard to the **elements** of the international application:\*
- ☐ the international application as originally filed.
- ☒ the description, pages **1-22**, as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☒ the claims, pages **23-29**, as originally filed,  
pages , as amended (together with any statement) under Article 19,  
pages , filed with the demand,  
pages **30, 31**, received on **7 September 2001** with the letter of **7 September 2001**
- ☒ the drawings, pages **1-7**, as originally filed,  
pages , filed with the demand,  
pages , received on with the letter of
- ☐ the sequence listing part of the description:  
pages , as originally filed  
pages , filed with the demand  
pages , received on with the letter of
2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.  
These elements were available or furnished to this Authority in the following language which is:
- ☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:
- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished
4. ☐ The amendments have resulted in the cancellation of:
- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/fig.
5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).\*\*

\* Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).

\*\* Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report

**IV. Lack of unity of invention**

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☐ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☒ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention in accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☒ not complied with for the following reasons:

1. Claims 1-46 directed to a charge storage device with means for removal of contaminants, its method of construction and a method for removing contaminants therefrom. These claims are characterised by means for sequestering, removing or drawing contaminants from the device and this is considered to comprise a first "special technical feature"

2. Claims 47-66 directed to a charge storage device and method of construction and including terminals, electrolyte and sheet electrodes with a separator enveloping one of the electrodes for maintaining the electrodes in spaced apart configuration. It is considered that a separator enveloping one of the electrodes for maintaining the electrodes in spaced apart configuration comprises a second "special technical feature"

The international search report covered all claims

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
- ☐ the parts relating to claims Nos.

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 2-12, 14-16, 18-23, 34-38, 64-66	YES
	Claims 1, 13, 17, 24-33, 39-63	NO
Inventive step (IS)	Claims 2-12, 14-16, 18-23, 34-38, 64-66	YES
	Claims 1, 13, 17, 24-33, 39-63	NO
Industrial applicability (IA)	Claims 1-66	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)**

The following claims lack novelty and inventive step because the features claimed therein are disclosed in the correspondingly referenced citations:

- 26, 31 - US 5445856 (col 4 lines 3-33)
- 26-33, 39-46 - US 4628011 (col 2 line 66 - col 3 line 68)
- 26, 27 - US 4218519 (col 3 line 7 - col 4 line 45, fig 3)
- 1, 17, 24, 26, 31 - EP 224932 (page 10 line 10 - page 13 line 28)
- 1, 13, 24-26 - JP 01-286262 (abstract)
- 24 - JP 61-203575 (abstract)
- 47-53, 58-63 - US 5926362 (col 2 lines 38-53, col 3 lines 6-23, col 5 lines 43-46, figs 1-3)
- 47-53, 58-63 - US 5601946 (col 4 lines 23-53, fig 1)
- 47-63 - US 5450279 (Example 1, fig 1)
- 47-53, 58-63 - US 4604333 (col 2 line 53 - col 3 line 23, figs 1-6)
- 47-63 - GB 2046019 (page 1 line 59 - page 2 line 2, figs)
- 47-63 - EP 854529 (page 7 lines 7-53, figs)

Features claimed in the remaining claims 2-12, 14-16, 18-23, 34-38, 64-66 are not disclosed in the citations, alone or in combination, and consequently these claims are novel and inventive.

**VIII. Certain observations on the international application**

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

1. Claim 55 appears to be redundant in view of claim 54.

## (12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
8 March 2001 (08.03.2001)

PCT

(10) International Publication Number  
**WO 01/16971 A1**

(51) International Patent Classification<sup>7</sup>: H01G 9/004,  
9/02, 9/08, H01M 2/14, 2/18

(21) International Application Number: PCT/AU00/01029

(22) International Filing Date: 30 August 2000 (30.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
PQ 2530 30 August 1999 (30.08.1999) AU

(71) Applicant (for all designated States except US): ENERGY  
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10, 12 Mars Road, Lane Cove, NSW 2066 (AU).

(72) Inventors; and

(75) Inventors/Applicants (for US only): PAUL, George,

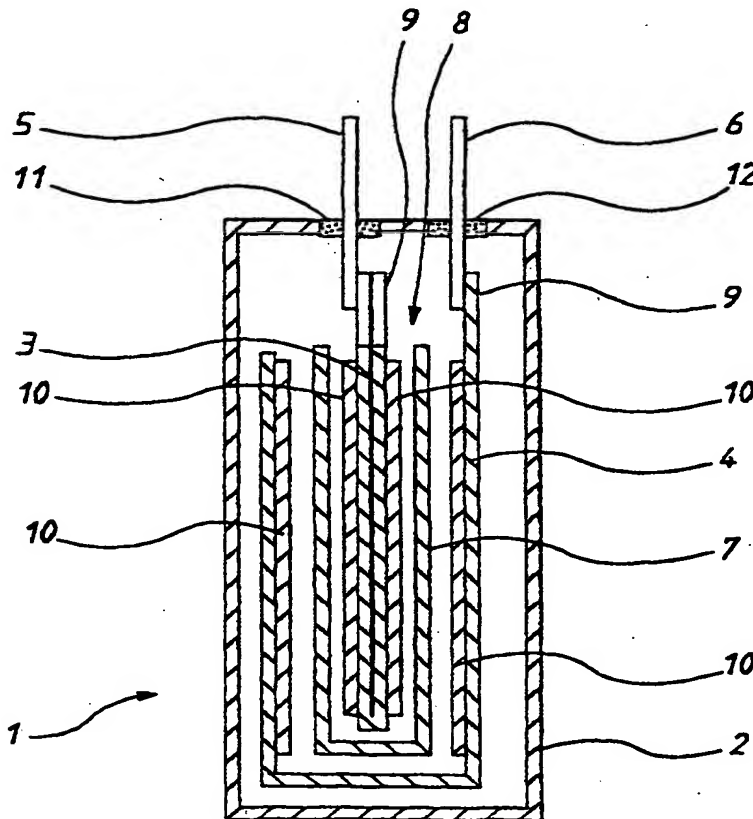
Lange [AU/AU]; 21A Greville Street, Chatswood  
West, NSW 2067 (AU). PYNENBURG, Rory, Al-  
bert, James [GB/AU]; 3/43 Aubin Street, Neutral Bay,  
NSW 2089 (AU). MAHON, Peter, John [AU/AU];  
8/45 Meadow Crescent, Meadowbank, NSW 2114 (AU).  
KESHISHIAN, Sarkis [AU/AU]; 2/684-686 Victoria  
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(74) Agent: BALDWIN SHELSTON WATERS; 60 Margaret  
Street, Sydney, NSW 2000 (AU).

(81) Designated States (*national*): AE, AG, AL, AM, AT, AU,  
AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ,  
DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR,  
HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR,  
LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ,  
NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM,  
TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

[Continued on next page]

(54) Title: A CHARGE STORAGE DEVICE



(57) Abstract: A charge storage device (1) includes a sealed prismatic housing (2). Two opposed folded rectangular aluminium electrodes (3, 4) are disposed within housing (2) and connected to respective metal terminals (5, 6) for allowing external electrical connection to the electrodes. A porous, electronically insulating separator material, e.g. Solupor™, sheet separator (7) is disposed intermediate electrodes (3, 4) for maintaining those electrodes in a fixed spaced apart configuration. An electrolyte (not shown) is also disposed intermediate the electrodes. Collecting means in the form of a scavenging agent is grafted to separator (7) for sequestering one or more predetermined contaminants from the housing.

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WO 01/16971 A1



(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— *With international search report.*

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

- 1 -

**TITLE: A CHARGE STORAGE DEVICE****Field of the Invention**

The present invention relates to a charge storage device.

The invention has been developed primarily for supercapacitors and will be  
5 described hereinafter with reference to that application. However, the invention is not  
limited to that particular field of use and is also suitable for other charge storage  
devices such as capacitors, batteries, fuel cells and the like.

**Discussion of the Prior Art**

Supercapacitors in the form of electric double layer capacitors are known.  
10 These capacitors generally include a housing for two aluminium electrodes each of  
which have a coating of activated carbon or the like on at least one side. The  
electrodes are typically wound or otherwise interleaved together with an intermediate  
separator and wetted with an appropriate electrolyte. The charge is stored in the  
electric double layer which is formed between the carbon and the electrolyte. Due to  
15 the large surface area per volume of the activated carbon the charge storage density of  
these devices is high.

One limitation of these supercapacitors is that, due to the nature of the known  
electrolytes, the housing must be sealed to prevent both leakage of the electrolyte -  
comprising of salt and solvents - from the housing and ingress of contaminants into  
20 the housing. A failure to sufficiently guard against the latter causes a degradation of  
the capacitor performance by reducing the maximum achievable operating voltage,  
increasing the leakage current, increasing the resistance and decreasing the available

- 2 -

capacitance. If the ingress is allowed to persist it will ultimately render the capacitor unworkable.

Batteries are also known and also use electrolytes, although, in distinction to supercapacitors, the energy is stored electrochemically. In any event, batteries also  
5 require the secure storage of the electrolyte within a housing to prevent its escape to the environment and to maintain its purity.

As a partial solution to ensuring that the electrolyte is maintained within the housing and free of contamination, much effort has been expended in providing the housing with walls that offer good barrier properties to the passage of fluids. An  
10 example of such an arrangement for a battery is disclosed in United States patent 5,445,856. This battery housing includes a wall made from a laminate having an oxygen scavenging agent either:

1. Incorporated in one of the layers of the laminate; or
2. Disposed between any two of the layers.

15 This feature is intended to increase the barrier properties of the housing to the ingress of contaminants through the laminate. While oxygen is the primary concern it is preferred that the agent also inhibits the transport of water through the laminate.

Notwithstanding the additional complexity, cost and improved barrier properties of this prior art housing, these types of charge storage devices are still very much  
20 subject to electrolyte contamination and degradation. Accordingly, over time, the performance of the device progressively deteriorates and the operation lifetime of the devices is compromised.



- 3 -

Disclosure of the Invention

It is an object of the present invention, at least in the preferred embodiment, to overcome or substantially ameliorate one or more of the disadvantages of the prior art, or at least to provide a useful alternative.

5       According to one aspect of the invention there is provided a charge storage device including:

        a housing;

        at least two opposed electrodes disposed within the housing;

        a separator disposed intermediate the electrodes;

10       an electrolyte disposed intermediate the electrodes; and

        collecting means disposed within the housing for sequestering one or more predetermined contaminants from the housing.

        Preferably, the electrodes each include a coating and the collecting means is one component of at least one of the coatings. More preferably, the coatings include an  
15       activated carbon and the collecting means is incorporated into the at least one coating prior to application to the electrodes. Even more preferably, the at least one coating includes a binder and the collecting means is contained within the binder.

        Preferably also, the collecting means is activated to sequester the one or more contaminants. More preferably, the collecting means is included within the binder  
20       prior to that activation. Even more preferably, the collecting means is activated after assembly of the charge storage device. In still further preferred embodiments, the activation is achieved by applying a predetermined voltage across the electrodes. In other embodiments the activation is achieved by electrochemical means.

- 4 -

In other embodiments, however, the collecting means is activated prior to inclusion of the collecting means within the binder. Moreover, in further embodiments, the collecting means is activated either prior to or during the assembly of the charge storage device.

5 In some preferred embodiments the collecting means is activated by exposure to predetermined wavelengths and intensities of electromagnetic radiation such as ultraviolet radiation. In other embodiments, the collecting means is exposed to an electron beam.

In other embodiments, the collecting means is contained within the electrolyte.

10 Preferably also, the collecting means sequesters oxygen from the housing. More preferably, the collecting means is the compound marked as ZERO 2 as sold and marketed by Southcorp Packaging. In other embodiments, the collecting means sequesters water from the electrolyte. In still further embodiments the collecting means sequesters other substances such as bromine and chlorine.

15 In a preferred form the sequestering results in the contaminants being isolated from the charge storage operation of the device. In other embodiments the sequestering results in a chemical change of the contaminants.

Preferably, where the collecting means is a component of the electrolyte, the sequestering results in additional electrochemical activity. More preferably, this  
20 additional activity improves the overcharge performance of the device.

In some embodiments the collecting means is a scavenging species. More preferably, the collecting means is grafted or otherwise incorporated into the separator.

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As will be appreciated by those skilled in the art, locating the collecting means with the separator will allow optimum removal of contaminants from the electrolyte.

Preferably also, the housing includes an interior surface and an exterior surface, and the collecting means is disposed on the interior surface.

5       According to a second aspect of the invention there is provided a method for constructing a charge storage device having a housing, the method including the step of providing collecting means disposed within the housing for sequestering one or more predetermined contaminants from the housing.

Preferably, the device includes two spaced apart electrodes, a separator  
10   intermediate the electrodes and an electrolyte for wetting the electrodes, the electrodes, separator and electrolyte being disposed within the housing and the method including the further step of grafting the collecting means to the housing. In other embodiments the method includes the step of grafting the collecting means to the separator. In still further embodiments the collecting means is disposed within the  
15   electrolyte.

According to a third aspect of the invention there is provided a charge storage device including:

a housing;  
at least two opposed electrodes disposed within the housing;  
20   a separator disposed intermediate the electrodes;  
an electrolyte disposed intermediate the electrodes; and  
collecting means for allowing removal of one or more predetermined  
contaminants from the housing.

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Preferably, the collecting means includes a port in the housing through which the one or more contaminants are selectively drawn. More preferably, the device includes sealing means to prevent ingress of contaminants through the port and into the housing. Even more preferably, the sealing means is a one way valve. In other  
5   embodiments, however, the sealing means is a septum extending across the port.

In a preferred form the collecting means also sequesters the one or more predetermined contaminants. Even more preferable, the collecting means is activated to initialise the sequestering and subsequently reactivated to:

effect release of the sequestered contaminants into the housing; and then  
10   once again commence the sequestering of the one or more predetermined contaminants from the housing.

Preferably also, the collecting means includes a port in the housing which is selectively subjected to an external negative pressure to draw from the housing the contaminants released upon reactivation of the collecting means.

15   In other embodiments, a scavenging agent is progressed through the port and into the housing for sequestering the one or more predetermined contaminants. More preferably, the scavenging agent is removed from the housing via the port. Even more preferably, the scavenging agent is activated for sequestering the one or more contaminants prior to progression in to the housing. In other embodiments, however,  
20   the activation occurs once the scavenging agent is in the housing. More preferably, the activation is achieved by exposure of the scavenging agent to predetermined wavelengths of electromagnetic radiation. Even more preferably, the housing includes a window which is at least partially transparent to those predetermined wavelengths.

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According to a fourth aspect of the invention there is provided a method for removing one or more predetermined contaminants from a charge storage device having a housing defining a cavity, the method including the steps of:

providing a port in the housing for allowing selective external fluidic

5 communication with the cavity; and

applying an external negative pressure to the port to draw the one or more contaminants from the cavity.

Preferably, the method includes the additional step of providing a positive pressure to the cavity for directing the one or more contaminants from the cavity and  
10 through the port. More preferably, the port is a one way valve. In other embodiments, however, the port is a self sealing septum and the method includes the additional steps of:

providing an insertion device having a through passage which extends between a first end and a second end;

15 applying a negative pressure to the first end; and

driving the second end through the septum to apply the negative pressure to the cavity such that the one or more contaminants are drawn into the through passage.

Preferably, the method includes the additional step of providing collecting means in the cavity for sequestering the one or more predetermined contaminants.

20 Even more preferably, the method includes the step of activating the collecting means to initialise the sequestering. Even more preferably, the method includes the step of reactivating the collecting means to effect release of the sequestered contaminants into the housing and thereafter applying the negative pressure to the first end. More

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preferably, the reactivation also allows the collecting means to recommence the sequestering of the one or more predetermined contaminants from the housing.

According to a fifth aspect of the invention there is provided a charge storage device including:

- 5       a housing;
- a first sheet electrode disposed within the housing;
- a second sheet electrode disposed within the housing adjacent to and opposed with the first sheet electrode;
- a separator for enveloping substantially all of the first electrode and for
- 10   maintaining the electrodes in a spaced apart configuration;
- an electrolyte disposed intermediate the electrodes; and
- two terminals extending from the respective electrodes and terminating outside the housing for allowing external electrical connection to the electrodes.

Preferably, the separator includes two opposed separator sheets which are

15   connected along at least one common edge and the first electrode is disposed between the separator sheets. More preferably, the separator sheets are integrally formed. Even more preferably, the separator sheets are integrally formed along the common edge.

Preferably also, each separator sheet includes a first edge and a second edge

20   spaced apart from the first, both of which extend away from the common edge. More preferably, each separator sheet also includes a third edge which extends between the first edge and the second edge, wherein the first edges are opposed and joined together

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and the second edges are opposed and joined together. Even more preferably, the third edges are opposed.

In a preferred form, the first electrode includes a first sub-sheet and a second sub-sheet which is opposed to the first. More preferably, the first and the second sub-sheets are opposed. Even more preferably, each of the first and second sub-sheets are joined along a common edge. Preferably also, the common edge between the first and second sub-sheets is disposed adjacent to the common edge between two opposed separator sheets.

According to another aspect of the invention there is provided a method of constructing a charge storage device having a housing, the method including the steps of:

disposing at least two opposed sheet electrodes within the housing;  
enveloping substantially all of a first one of the electrodes with a separator for maintaining the electrodes in a spaced apart configuration;  
disposing an electrolyte intermediate the electrodes; and  
providing two terminals extending from the respective electrodes and terminating outside the housing for allowing external electrical connection to the electrodes.

Preferably, the separator includes two opposed separator sheets connected along at least one common edge and the method includes the further step of disposing the first electrode between the separator sheets. More preferably, the separator sheets are integrally formed. Even more preferably, the separator sheets are integrally formed along the common edge.

- 10 -

Preferably also, each separator sheet includes a first edge and a second edge spaced apart from the first, both of which extend away from the common edge. More preferably, each separator sheet also includes a third edge which extends between the first edge and the second edge, wherein the method includes the further step of joining  
5 together the first edges and joining together the second edges. Even more preferably, the third edges are opposed.

#### Brief Description of the Drawings

Preferred embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

10 Figure 1 is a schematic cross section of a supercapacitor according to the invention;

Figure 2 is a plan view of a separator for the supercapacitor of Figure 1;

Figure 3 is a schematic plan view of one of the electrodes of the supercapacitor of Figure 1;

15 Figure 4 is a schematic perspective view of an electrode assembly including the separator of Figure 2 and the electrode of Figure 3;

Figure 5 is a schematic perspective view of the assembly of Figure 4 nested within a like electrode to that shown in Figure 3;

Figure 6 is a schematic perspective view of an alternative supercapacitor  
20 according to the invention; and

Figure 7 is a schematic enlarged sectional view of the septum included in the supercapacitor of Figure 6.



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Preferred Embodiments of the Invention

Referring to Figure 1, a charge storage device 1 includes a sealed prismatic housing 2. Two opposed folded rectangular aluminium electrodes 3 and 4 are disposed within housing 2 and connected to respective metal terminals 5 and 6 for allowing external electrical connection to the electrodes. A Solupor™ sheet separator 7 is disposed intermediate electrodes 3 and 4 for maintaining those electrodes in a fixed spaced apart configuration. An electrolyte (not shown) is also disposed intermediate the electrodes. Collecting means in the form of a scavenging agent is grafted to separator 7 for sequestering one or more predetermined contaminants from the housing.

Separator 7 is formed in a "pocket" configuration, wherein it is folded back upon itself and the transverse ends secured together for providing an opening 8 between the transverse ends. For ease of illustration, separator 7 is shown as having two fold lines. In practice, however, a single fold line is used as the separator is abutted directly against the opposed electrodes. The porous nature of the separator allows the movement of ions in the electrolyte between the electrodes.

Each electrode is formed from a single like aluminium sheet having at least one tab 9 which is electrically engaged with the respective terminals 5 and 6. The electrodes are folded into the overlapping and nested configuration shown in the drawing. Again, it will be appreciated that for ease of illustration electrode 4 is shown with two fold lines. In practice, however, a single fold is made as this electrode is abutted directly against separator 7.

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Electrode 3 is received within opening 8 and enveloped by separator 7 such that only tab 9 extends from the "pocket" or pouch. This electrode and separator combination is then inserted into the folded electrode 4 to complete a single capacitive cell. While in this embodiment only a single cell is illustrated, in other embodiments use is made of two or more such cells. The electrode area of the electrodes is about 102 cm<sup>2</sup> which provides a nominal capacitance of about 28 Farads at 2.5 Volts.

Each of electrodes 3 and 4 includes a high surface area coating 10 of activated carbon particles. This coating is of a predetermined thickness and includes a binder to facilitate intimate engagement between the carbon particles and the electrodes.

10 In this embodiment the scavenging agent is the compound marked as ZERO 2 as sold and marketed by Southcorp Packaging. About 25 mg of the compound is grafted to separator 7 during the manufacture of the supercapacitor. More particularly, one of the process steps of manufacture includes interleaving the separator with the electrodes. Immediately prior to this step, the grafting occurs, followed by activation  
15 of the scavenging agent by UV radiation of a predetermined wavelength and intensity. The separator with the activated scavenging agent is then interleaved with the electrodes in the controlled manufacturing environment. As would be understood by those skilled in the art, it is important to conduct supercapacitor and other energy storage manufacture in controlled conditions to minimise any contamination.  
20 Accordingly, notwithstanding that the scavenging agent has been activated and that it will almost immediately commence sequestering of contaminants, the location of the still partially constructed supercapacitor within the standard controlled environment minimises exposure to those contaminants.

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As terminals 5 and 6 extend from the inside to the outside of housing 2 they are sealingly engaged intermediate their respective ends with the housing. In this embodiment the sealing engagement is effected by two rubber grommets 11 and 12. In other embodiments use is made of grommets constructed from other materials or combinations of materials. For example, some devices make use of silicon sealing compounds and adhesives.

In any event, the commercially available sealing means are not entirely effective and have a finite working lifespan as they progressively degrade over time. Accordingly, with most if not all sealing arrangements there will inevitably be some ingress of contaminants into the housing over the operation life time of the supercapacitor or other charge storage device.

The present embodiment provides a prolonged operational life for supercapacitor 1 as any contaminants that do enter housing 2 will be preferentially rendered inert to the operation of the supercapacitor by the scavenging agent that is grafted to separator 7. The quantity of scavenging agent used in this embodiment sequesters up to about  $0.2 \text{ cm}^3$  of oxygen. In other embodiments more or less of the scavenging agent is used. For example, in an alternative embodiment utilising a plurality of the capacitive cells, each pouch or pocket of the separator has about 20 mg of the ZERO 2 compound grafted thereto.

As discussed below, the scavenging agent is, in other embodiments, located other than on the separator. However, grafting to the separator has a number of advantages, including the disposition of the scavenging agent for the sequestering of contaminants that are disposed between the electrodes. That is, the ingress of

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contaminants into housing 2 adversely affects performance if those contaminants enter the electrochemically active region between the electrodes. Activity in this region can physically, chemically or electrically interfere with the charge storage ability of the supercapacitor. Consequently, in this embodiment, any contaminant that is located  
5 within the active region is increasingly likely to be sequestered.

As would be appreciated by those skilled in the art from the teaching herein, notwithstanding the use of the invention, manufacturing tolerances and raw material quality variations will continue to ensure a variance of actual life span of supercapacitors and other energy storage devices. The present invention, however,  
10 when used with a given manufacturing technique, provides an increase to the mean life span that would otherwise be obtained.

In other embodiments of the invention (not shown) the scavenging compound is grafted or otherwise incorporated into the housing. That is, the housing defines an interior surface and an exterior surface wherein the interior surface provides a site for  
15 the scavenging agent.

The use of a scavenging agent within housing 2 allows the level of detrimental contaminants to be reduced. Accordingly, for a given manufacturing process, the failure rate for the supercapacitors is reduced. An alternative is to vary the manufacturing process. That is, the construction of supercapacitors involves  
20 progressing the various constituents through a sequence of carefully maintained environments to ensure sufficiently low levels of contamination occur. These environments are expensive to provide and consistently maintain. However, with the

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use of an internally located scavenging agent some contamination is tolerable without adversely affecting the failure rate of the supercapacitor ultimately produced.

In embodiments where the scavenging agent is not exhausted due to impurities or contaminants introduced in the manufacturing process, it allows a continued  
5 removal of undesirable substances from the housing and, in particular, from the electrolyte. Accordingly, the ingress of contaminants into the housing will not, during the useful life of the scavenging agent, compromise the performance of the supercapacitor.

The prior art devices have been concerned with the barrier properties of the  
10 walls of the respective housings. However, the present inventor has discovered that the major concern is not the walls themselves but the imperfect seal between a wall and the protruding terminals, or between adjacent walls. To address this issue, the preferred embodiments of the invention have the sequestering agent disposed within the housing rather than within the confines of a wall, as is the case with the device  
15 disclosed in United States patent 5,445,856. That is, the preferred embodiments described herein disposed the agent to capture not only specific contaminants that are in transit through a wall, but also those that gain entry to the housing via other paths.

Electrode 3 and 4 will now be described in more detail with reference to Figures 2 to 4. More particularly, and as best shown in Figure 3, electrode 3 is substantially  
20 rectangular and includes two rectangular sub-sheets 15 and 16. The sub-sheets are integrally formed and symmetrical about a fold line 17 which defines a common edge 18. Sheets 15 and 16 include respective integrally formed rectangular sub-tabs 19 and 20 which, as shown in Figure 4, abut to collectively define tab 9.

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Sheet 15 includes two spaced apart and parallel edges 21 and 22 which extend away normally from edge 18. A further edge 23 extends between edges 21 and 22. As also shown in Figure 3, tab 19 extends from away from edge 23 adjacent to where that edge meets with edge 22. Similarly, sheet 16 includes two spaced apart and parallel edges 25 and 26 which extend away normally from edge 18. A further edge 27 extends between edges 25 and 26. Similarly also, tab 20 extends from away from edge 27 adjacent to where that edge meets with edge 26.

Electrode 3 is coated on one side only with the activated carbon and then folded about line 17 such that the coated side is outwardly facing, as shown in Figure 1.

10 Electrode 4 is the same as electrode 3 only that it is interleaved in the opposite sense so that the respective tabs 9 are spaced apart. This will be described in further detail below. For convenience, corresponding features of the electrodes will be designated with corresponding reference numerals.

Separator 7 is shown, not to scale, in plan in Figure 2 and includes two rectangular sub-sheets 31 and 32 which are integrally formed along a common edge 33. This edge also defines a fold line 34. Sheet 31 also includes two spaced apart and parallel edges 35 and 36 which extend away normally from edge 33. A free edge 37 extends between edges 35 and 36. Similarly, sheet 32 includes two spaced apart and parallel edges 39 and 40 which extend away normally from edge 33. A free edge 41 extends between edges 39 and 40.

During manufacture, electrode 3 is folded about line 17 such that the coated sides of sheets 15 and 16 are opposed and outwardly facing. Additionally, tabs 19 and 20 are abutted. Separately, separator 7 is folded about line 34 such that edges 35 and

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39 are parallel and abutted together, edges 36 and 40 are parallel abutted together and edges 37 and 41 are parallel and adjacent to one another. Thereafter, edges 35 and 39 are joined together and edges 35 and 39 are joined together. In some embodiments this is achieved with adhesive, while in other embodiments heat welding or other heat treatment is utilised. In still further embodiments the edges are not joined.

As best illustrated in Figure 4, electrode 3 is then nested within the "pouch" or "pocket" formed by separator 7. As shown, the separator envelopes substantially all of electrode 3 and, as will be described below, maintains electrodes 3 and 4 in a spaced apart configuration. Tab 9 extends outwardly beyond adjacent edges 37 and 41 to allow its electrical connection to terminal 5. For ease of illustration, in Figure 4 separator 7 is shown with edges 36 and 40 joined by way of heat welding, while edges 35 and 39 are adjacent, although not yet joined.

Electrode 4 is then formed by folding a like coated sheet to that which forms electrode 3. More particularly, the fold is made along fold line 18 such that that the coated sides of sheets 15 and 16 are opposed and inwardly facing. Additionally, tabs 19 and 20 are adjacent to each other and opposed. The assembly of Figure 4 is then nested within electrode 4, as best illustrated in Figure 5, such that the respective tabs 9 of the electrodes are spaced apart. Tabs 19 and 20 of electrode 4 are then abutted and secured to terminal 6 to allow external electrical connection with the electrode.

The electrode assembly of Figure 5 is referred to as a single cell and, as would be appreciated by a skilled addressee from the teaching herein, a plurality of the cells are able to be connected in parallel to proportionally increase the capacitance of supercapacitor 1. In other embodiments, a plurality of the cells are stacked in parallel

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such that the respective tabs 9 for like electrodes 3 and 4 form two spaced apart stacks of like tabs. The tabs in each stack are then clamped together and the stacks electrically connected to respective terminals 5 and 6.

Referring now to Figure 6 and Figure 7, where corresponding features are denoted by corresponding reference numerals, there is illustrated a supercapacitor 45. The supercapacitor housing 2 is sealed and one sidewall 46 includes collecting means in the form of a septum 47. As best shown in Figure 7, wall 46 includes an inner side 49, an outer side 50 and an aperture 51. Septum 47 includes an annular mounting formation 53 which is sealingly engaged with side 50 of wall 46 and which surrounds aperture 51. A circular self-sealing barrier membrane 54 extends across formation 53 and creates a seal between the interior of the housing and atmosphere.

Housing 2 also includes a sidewall 57 having a rectangular window 58 of material which is at least partially transparent to ultraviolet radiation. In other embodiments, window 58 is differently shaped and which extends over a smaller portion of wall 57. In still further embodiments, window 58 is disposed in a sidewall other than that of wall 57. Moreover, other embodiments include window 58 in the base or top of housing 2.

Supercapacitor 45 includes a plurality of the capacitor cells referred to above which are connected in parallel. The like electrodes are electrically connected to respective terminals 5 and 6.

Following the manufacture of supercapacitor 45, a collection device (not shown) in the form of a needle is inserted through membrane 54. The collection device also includes pressure means for creating a negative pressure and a conduit for linking the



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pressure means to the needle such that gases contained within housing 2 are drawn through the needle and the conduit. That is, the collection device allows the removal of gaseous contaminants from the housing. The removal occurs immediately following manufacture. In other embodiments, however, the removal is performed at other times  
5 and, as such, provides a reconditioning of the supercapacitor. In still further embodiments both the initial removal and reconditioning is performed. For example, in some cases, sensing circuitry is connected in parallel with the supercapacitor to determine when the time constant or other electrical property of the supercapacitor varies by a predetermined percentage from the respective value provided at the time of  
10 manufacture. When this variation is detected it provides a warning signal to alert the user that reconditioning is warranted.

Once sufficient gases have been withdrawn the pressure means is deactivated and the needle withdrawn from the septum. The self sealing effect of the septum will prevent the ingress of any gases or moisture into the housing.

15 The other embodiments, once the pressure means is deactivated, a scavenging agent is released into the conduit and drawn into housing 2 due to the residual negative pressure. This agent progresses into the electrolyte and is available, once activated, for sequestering oxygen and/or other contaminants from housing 2. Activation of the agent occurs by directing ultraviolet radiation through window 58  
20 and into housing 2. Other agents are activated by radiation other than ultraviolet radiation and, in these cases, window 58 is at least partially transparent to the wavelength of the radiation required.

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In other embodiments, such as where the scavenging agent is grafted to the separator, supercapacitor 45 operates in the following manner. After all the components are placed within housing 2, and the housing sealed, the agent is activated by directing the appropriate radiation through window 58. After a given operational  
5 lifetime, or after testing shows that contaminants have degraded the performance of the supercapacitor, the agent is again activated. However, this subsequent activation will cause the agent to release the sequestered contaminants into housing 2. This being the case, the collection device referred to above is then utilised to apply a negative pressure to the housing such that the contaminants are drawn through the  
10 needle and conduit away from the housing. Once the pressure means are deactivated the needle is withdrawn from septum 47 and membrane 54 self seals. Thereafter, the agent will continue to sequester contaminants that subsequently enter housing 2. This process of reconditioning is completed as required.

In other embodiments, septum 47 is replaced with a mechanical one way valve.  
15 Another embodiment of the invention, in the form of supercapacitor 60, is illustrated in Figure 8. This supercapacitor includes a housing 61 formed from two like opposed flexible laminate thermoformable sheets 63 and 64. The sheets are generally rectangular and heat sealed about their common periphery 65.

The opposed sheets define an internal cavity in which is disposed the other  
20 components (not shown) of supercapacitor 60. As with the other embodiments of the invention, the components that are internal to the cavity are two opposed sheet electrodes, a porous separator disposed intermediate the electrodes, and an electrolyte for allowing ionic conduction between the electrodes.

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Supercapacitor 60 also includes two terminals 69 and 70 which are electrically connected to the respective electrodes and which extend from inside the cavity to outside the cavity for allowing electrical connection of the supercapacitor to external circuitry.

5           Terminals 69 and 70 are aluminium strips that are sealingly engaged, intermediate their respective ends, with the periphery of sheets 63 and 64. This sealing engagement is, however, imperfect due to the very different and incompatible nature of the film and the terminals. This places considerable reliance on the sealant itself to adhere the two materials together.

10           In this embodiment the sealant is an adhesive sold under the trade name Nucrel. While this provides good adhesive properties it is sensitive the manufacturing process and susceptible to a loss of adhesion during the lifetime of the capacitor. Moreover, while the function of the sealant as an adhesive is adequate, its ability to act as a barrier to ingress of contaminants is less effective. The solution provided by this  
15           embodiment is the inclusion within the separator of a collecting agent to sequester any oxygen that penetrates the housing by way of the imperfect sealing of the sealant against either or both of the aluminium terminals or the sheets 63 and 64, or by progress of the contaminants through the sealant itself.

          The supercapacitors of the preferred embodiments provide a longer operation  
20           lifetime than their predecessors. Alternatively, the operation lifetime is maintained and the cost of manufacturing reduced.

          The preferred embodiments also offer a significant range of possible dispositions of the collecting means. Accordingly a wide variety of manufacturing

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processes can easily accommodate the inclusion of this feature. That is, there is considerable design flexibility in including the collecting means of the invention within a supercapacitor. In most cases this is achieved with minimal departure from existing manufacturing steps.

5       The preferred embodiments described above have arisen from the understanding that there will always be some contamination of the electrolyte either during the manufacturing process or over time as contaminants penetrate the housing. On this basis, some embodiments have the collecting means disposed within the housing to sequester or otherwise chemically capture the contaminants that are within the housing  
10 while, in other embodiments, the collecting means allows removal of the contaminants from within the housing. That is, these embodiments are concerned with addressing the issue of contaminants within the housing, not providing a barrier to those contaminants from getting there in the first place. That barrier function is performed by the housing itself, both in the form of the materials from which it is constructed and  
15 the manner in which those materials are combined.

Although the invention has been described with reference to specific examples, it will be appreciated by those skilled in the art that it may be embodied in many other forms and in many other technologies. More particularly, the invention is also applicable to ultracapacitors, batteries such as Li ion batteries, fuel cells,  
20 electrochemical catalysts, other ion specific electrodes and the like.

## CLAIMS:-

1. A charge storage device including:  
a housing;  
at least two opposed electrodes disposed within the housing;  
5 a separator disposed intermediate the electrodes;  
an electrolyte disposed intermediate the electrodes; and  
collecting means disposed within the housing for sequestering one or more  
predetermined contaminants from within the housing.
2. A device according to claim 1 wherein the electrodes each include a coating and the  
10 collecting means is one component of at least one of the coatings.
3. A device according to claim 2 wherein the coatings include an activated carbon and  
the collecting means is incorporated into the at least one coating prior to application to the  
electrodes.
4. A device according to claim 3 wherein the at least one coating includes a binder and  
15 the collecting means is contained within the binder.
5. A device according to claim 4 wherein the collecting means is activated to sequester  
the one or more contaminants.
6. A device according to claim 5 wherein the collecting means is included within the  
binder prior to that activation.
- 20 7. A device according to claim 5 wherein the collecting means is activated after  
assembly of the charge storage device.
8. A device according to claim 7 wherein the activation is achieved by applying a  
predetermined voltage across the electrodes.

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9. A device according to claim 5 wherein the activation is achieved by electrochemical means.
10. A device according to claim 5 wherein the collecting means is activated prior to inclusion of the collecting means within the binder.
- 5 11. A device according to claim 5 wherein the collecting means is activated either prior to or during the assembly of the charge storage device.
12. A device according to claim 5 wherein the collecting means is activated by exposure to predetermined wavelengths and intensities of electromagnetic radiation.
13. A device according to claim 1 wherein the collecting means is contained within the  
10 electrolyte.
14. A device according to claim 1 wherein the collecting means sequesters oxygen from the housing.
15. A device according to claim 1 wherein the collecting means sequesters water from the electrolyte.
- 15 16. A device according to claim 1 wherein the collecting means sequesters bromine or chlorine from the housing.
17. A device according to claim 1 wherein the sequestering results in the contaminants being isolated from the charge storage operation of the device.
18. A device according to claim 1 wherein the sequestering results in a chemical change  
20 of the contaminants.
19. A device according to claim 1 wherein the collecting means is a component of the electrolyte and the sequestering results in additional electrochemical activity.
20. A device according to claim 19 wherein the additional activity improves the overcharge performance of the device.

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21. A device according to claim 1 wherein the collecting means is a scavenging species.
22. A device according to claim 1 wherein the collecting means is grafted or otherwise incorporated into the separator.
23. A device according to claim 1 wherein the housing includes an interior surface and  
5 an exterior surface, and the collecting means is disposed on the interior surface.
24. A method for constructing a charge storage device having a housing, the method including the step of providing collecting means disposed within the housing for sequestering one or more predetermined contaminants from the housing.
25. A method according to claim 24 wherein the device includes two spaced apart  
10 electrodes, a separator intermediate the electrodes and an electrolyte for wetting the electrodes, the electrodes, separator and electrolyte being disposed within the housing, the method also including one or more of the following steps: grafting the collecting means to the housing; grafting the collecting means to the separator; and disposing the collecting means within the electrolyte.
- 15 26. A charge storage device including:  
a housing;  
at least two opposed electrodes disposed within the housing;  
a separator disposed intermediate the electrodes;  
an electrolyte disposed intermediate the electrodes; and  
20 collecting means for allowing removal of one or more predetermined contaminants from the housing.
27. A device according to claim 26 wherein the collecting means includes a port in the housing through which the one or more contaminants are selectively drawn.

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28. A device according to claim 27 including sealing means to prevent ingress of contaminants through the port and into the housing.

29 A device according to claim 28 wherein the sealing means is a one way valve.

30. A device according to claim 28 wherein the sealing means is a septum extending  
5 across the port.

31. A device according to claim 26 wherein the collecting means also sequesters the one or more predetermined contaminants.

32. A device according to claim 26 wherein the collecting means is activated to initialise the sequestering and subsequently reactivated to:

10 effect release of the sequestered contaminants into the housing; and then  
once again commence the sequestering of the one or more predetermined  
contaminants from the housing.

33. A device according to claim 32 wherein the collecting means includes a port in the housing which is selectively subjected to an external negative pressure to draw from the  
15 housing the contaminants released upon reactivation of the collecting means.

34. A device according to claim 27 wherein a scavenging agent is progressed through the port and into the housing for sequestering the one or more predetermined contaminants.

35. A device according to claim 34 wherein the scavenging agent is removed from the housing via the port.

20 36. A device according to claim 35 wherein the scavenging agent is activated for sequestering the one or more contaminants prior to progression into the housing.

37. A device according to claim 36 wherein the activation is achieved by exposure of the scavenging agent to predetermined wavelengths of electromagnetic radiation.



38. A device according to claim 37 wherein the housing includes a window which is at least partially transparent to those predetermined wavelengths.

39. A method for removing one or more predetermined contaminants from a charge storage device having a housing defining a cavity, the method including the steps of:

5       providing a port in the housing for allowing selective external fluidic communication with the cavity; and

          applying an external negative pressure to the port to draw the one or more contaminants from the cavity.

40. A method according to claim 39 including the additional step of providing a positive  
10   pressure to the cavity for directing the one or more contaminants from the cavity and through the port.

41. A method according to claim 40 wherein the port is a one way valve.

42. A method according to claim 40 wherein the port is a self sealing septum and the method includes the additional steps of:

15       providing an insertion device having a through passage which extends between a first end and a second end;

          applying a negative pressure to the first end; and

          driving the second end through the septum to apply the negative pressure to the cavity such that the one or more contaminants are drawn into the through passage.

20   43. A method according to claim 39 including the additional step of providing collecting means in the cavity for sequestering the one or more predetermined contaminants.

44. A method according to claim 43 including the step of activating the collecting means to initialise the sequestering.

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45. A method according to claim 44 including the step of reactivating the collecting means to effect release of the sequestered contaminants into the housing and thereafter applying the negative pressure to the first end.

46. A method according to claim 45 wherein the reactivation also allows the collecting  
5 means to recommence the sequestering of the one or more predetermined contaminants from the housing.

47. A charge storage device including:

a housing;

a first sheet electrode disposed within the housing;

10 a second sheet electrode disposed within the housing adjacent to and opposed with the first sheet electrode;

a separator for enveloping substantially all of the first electrode and for maintaining the electrodes in a spaced apart configuration;

an electrolyte disposed intermediate the electrodes; and

15 two terminals extending from the respective electrodes and terminating outside the housing for allowing external electrical connection to the electrodes.

48. A device according to claim 47 wherein the separator includes two opposed separator sheets which are connected along at least one common edge and the first electrode is disposed between the separator sheets.

20 49. A device according to claim 48 wherein the separator sheets are integrally formed.

50. A device according to claim 49 wherein the separator sheets are integrally formed along the common edge.

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51. A device according to claim 50 wherein each separator sheet includes a first edge and a second edge spaced apart from the first, both of which extend away from the common edge.

52. A device according to claim 51 wherein each separator sheet also includes a third  
5 edge which extends between the first edge and the second edge, wherein the first edges are opposed and joined together and the second edges are opposed and joined together.

53. A device according to claim 52 wherein the third edges are opposed.

54. A device according to claim 50 wherein the first electrode includes a first sub-sheet and a second sub-sheet which is opposed to the first.

10 55. A device according to claim 54 wherein the first and the second sub-sheets are opposed.

56. A device according to claim 55 wherein each of the first and second sub-sheets are joined along a common edge.

57. A device according to claim 56 wherein the common edge between the first and  
15 second sub-sheets is disposed adjacent to the common edge between two opposed separator sheets.

58. A method of constructing a charge storage device having a housing, the method including the steps of:

disposing at least two opposed sheet electrodes within the housing;

20 enveloping substantially all of a first one of the electrodes with a separator for maintaining the electrodes in a spaced apart configuration;

disposing an electrolyte intermediate the electrodes; and

providing two terminals extending from the respective electrodes and terminating outside the housing for allowing external electrical connection to the electrodes.

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59. A method according to claim 58 wherein the separator includes two opposed separator sheets connected along at least one common edge and the method includes the further step of disposing the first electrode between the separator sheets.

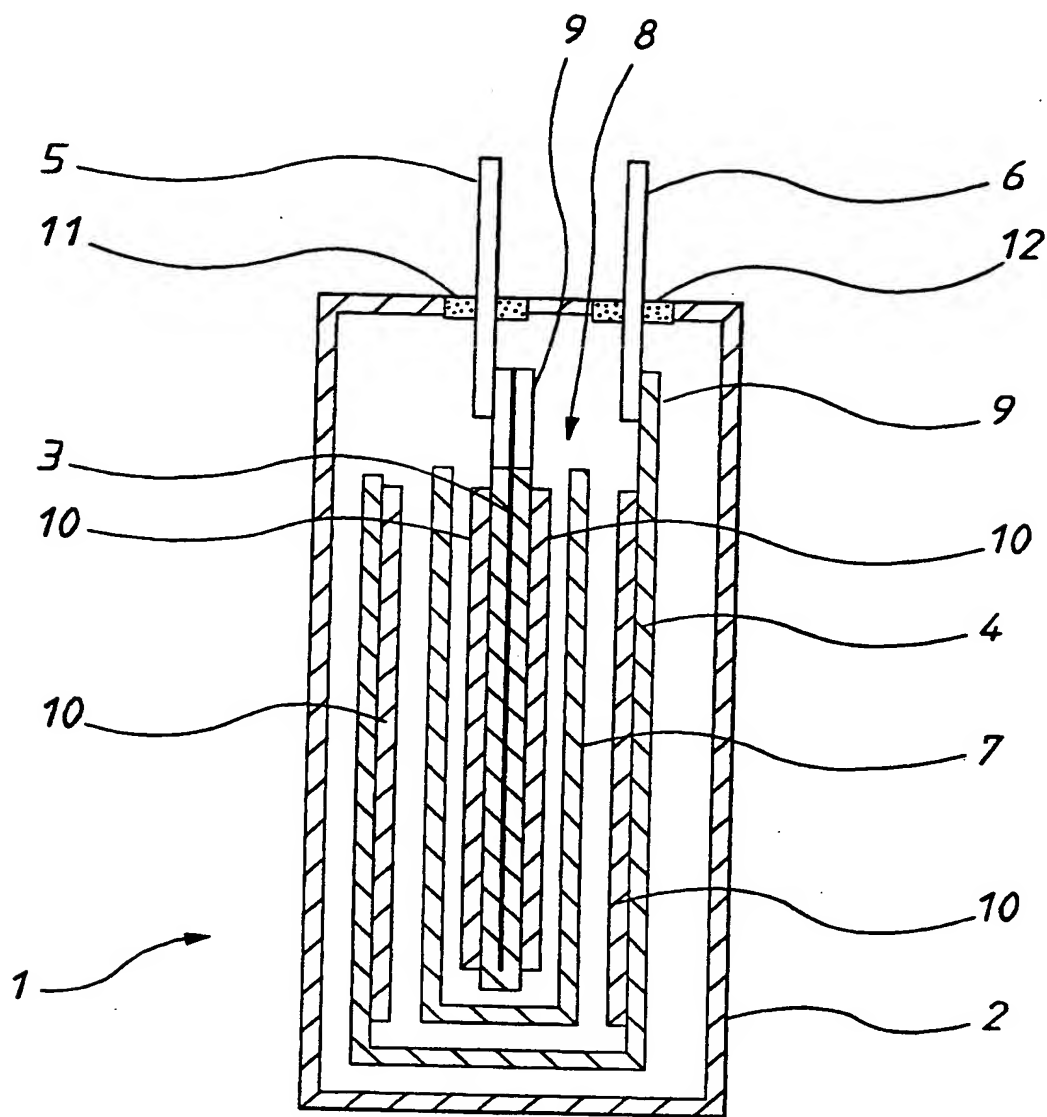
60. A method according to claim 59 wherein the separator sheets are integrally formed  
5 along the common edge.

61. A method according to claim 60 wherein each separator sheet includes a first edge and a second edge spaced apart from the first, both of which extend away from the common edge.

62. A method according to claim 61 wherein each separator sheet also includes a third  
10 edge which extends between the first edge and the second edge, wherein the method includes the further step of joining together the first edges and joining together the second edges.

63. A method according to claim 62 wherein the third edges are opposed.

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FIG. 1

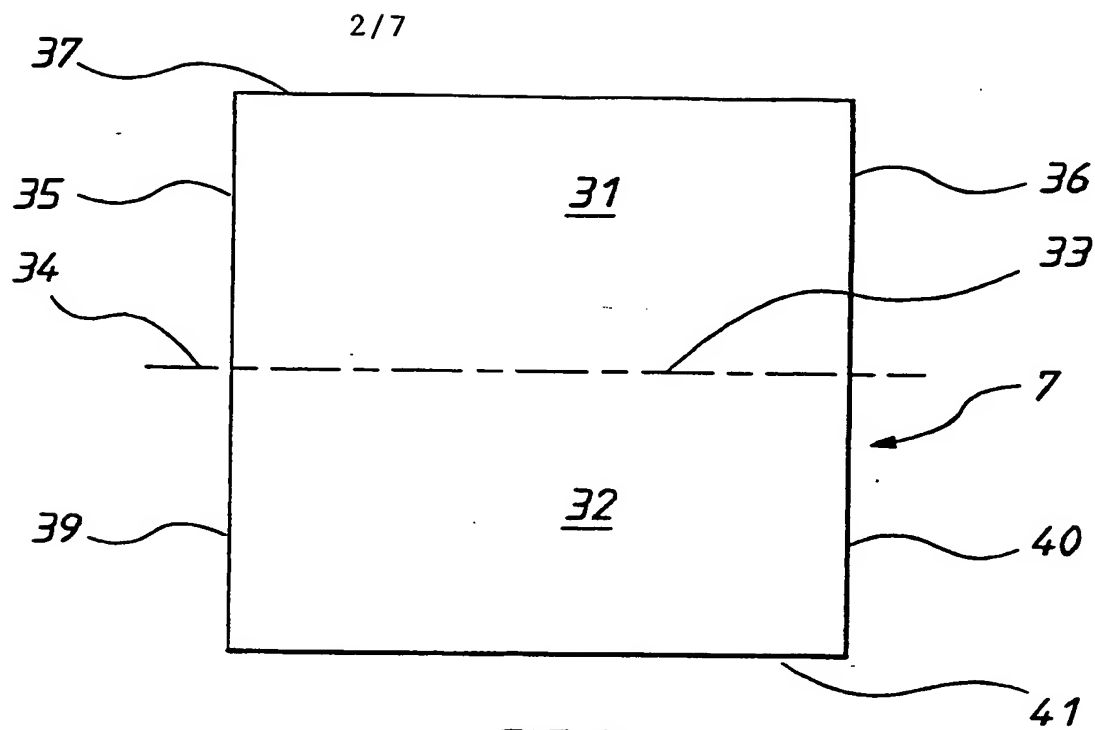


FIG. 2

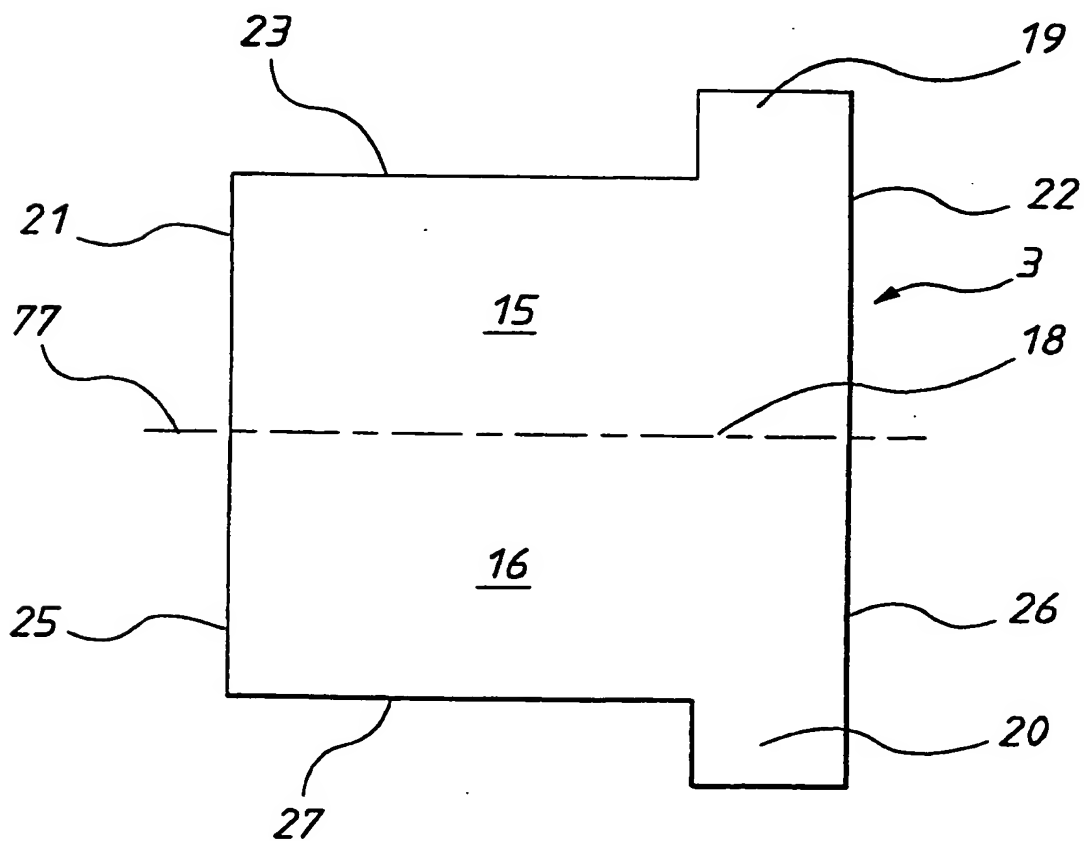
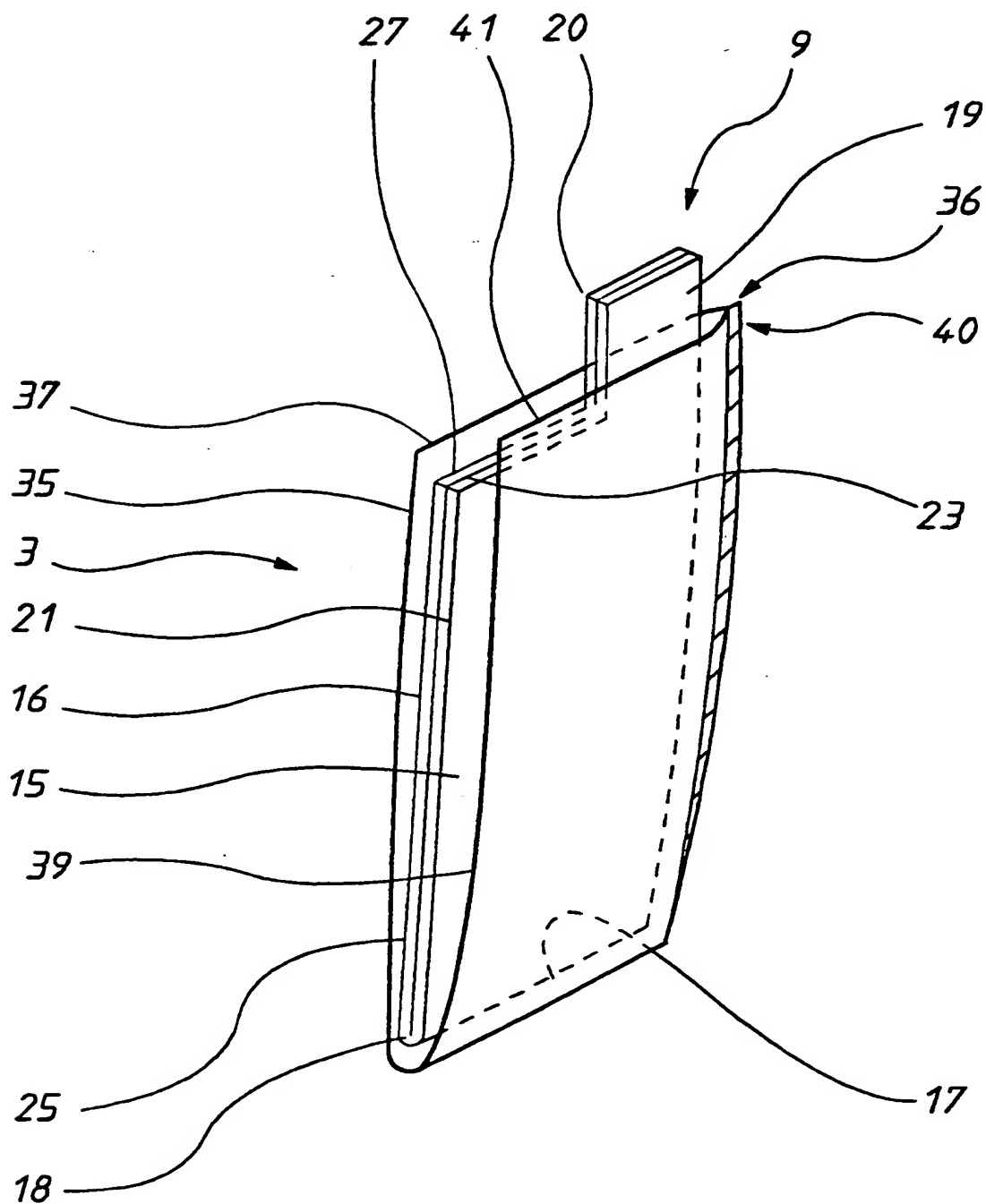


FIG. 3

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FIG. 4

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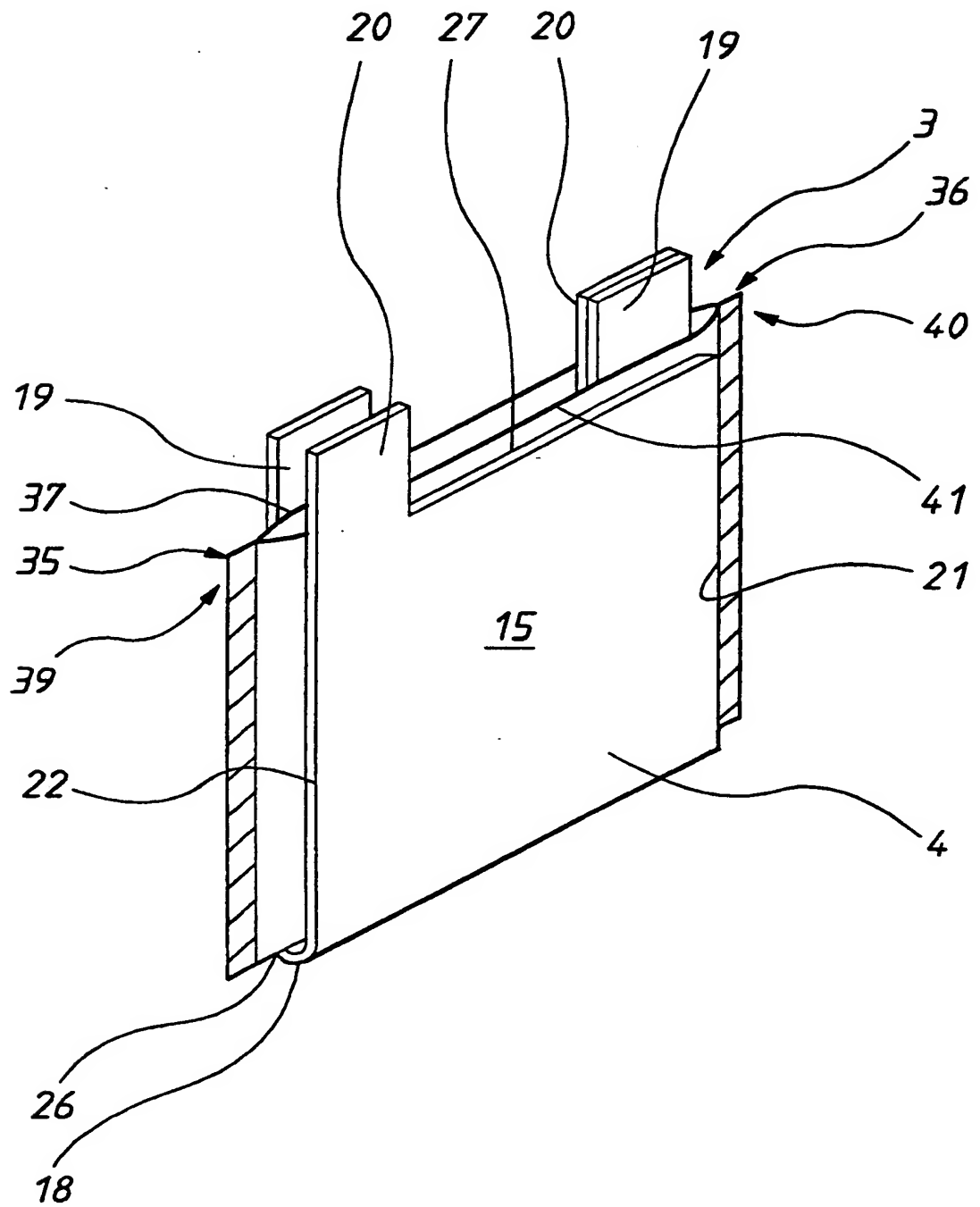
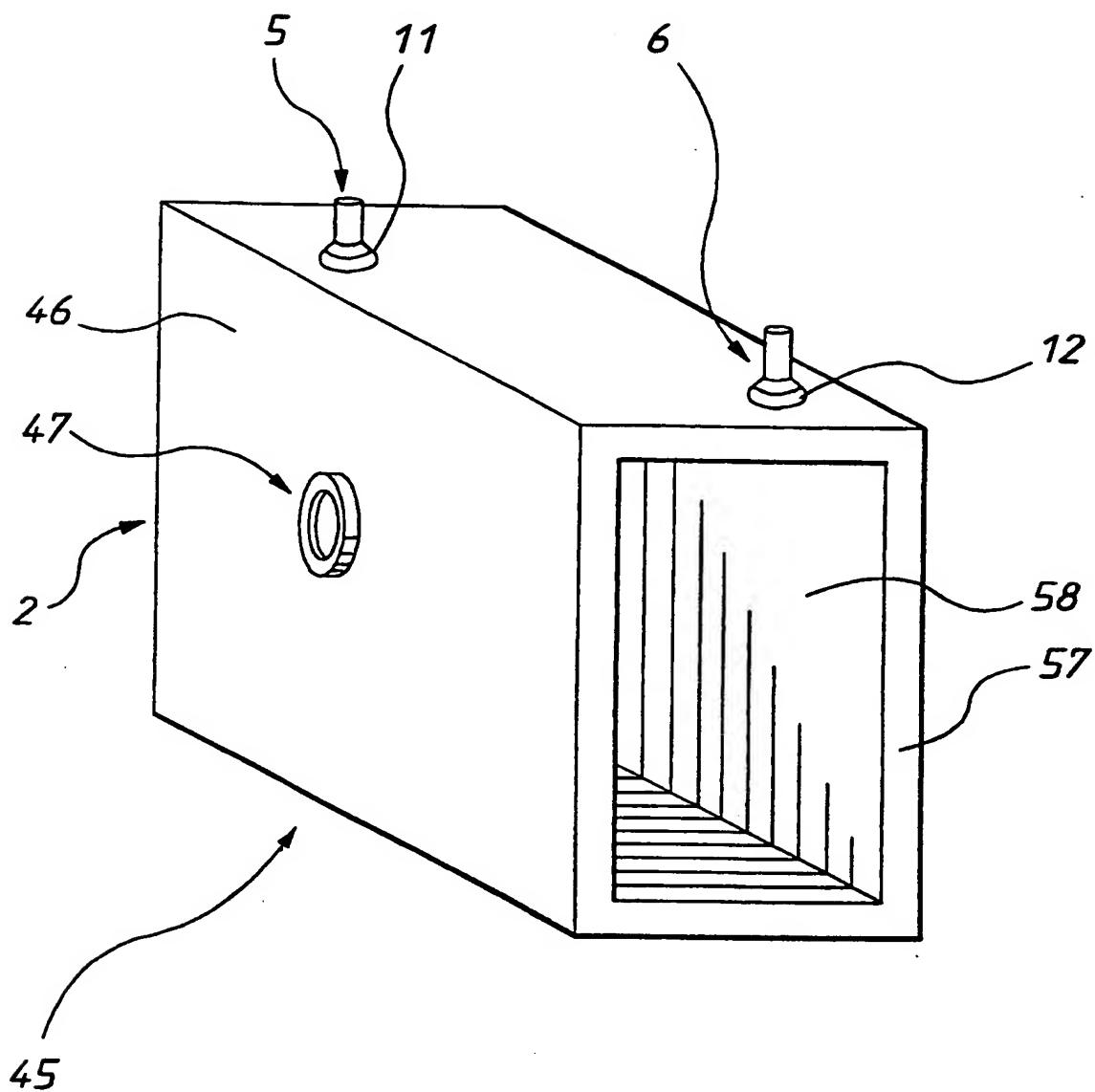
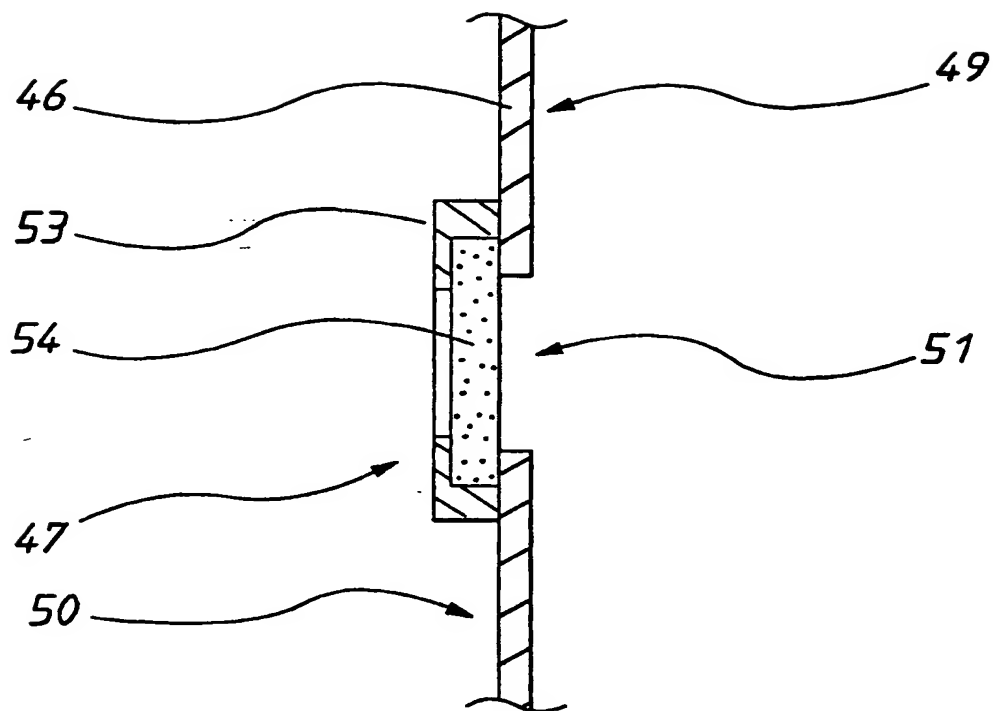


FIG. 5

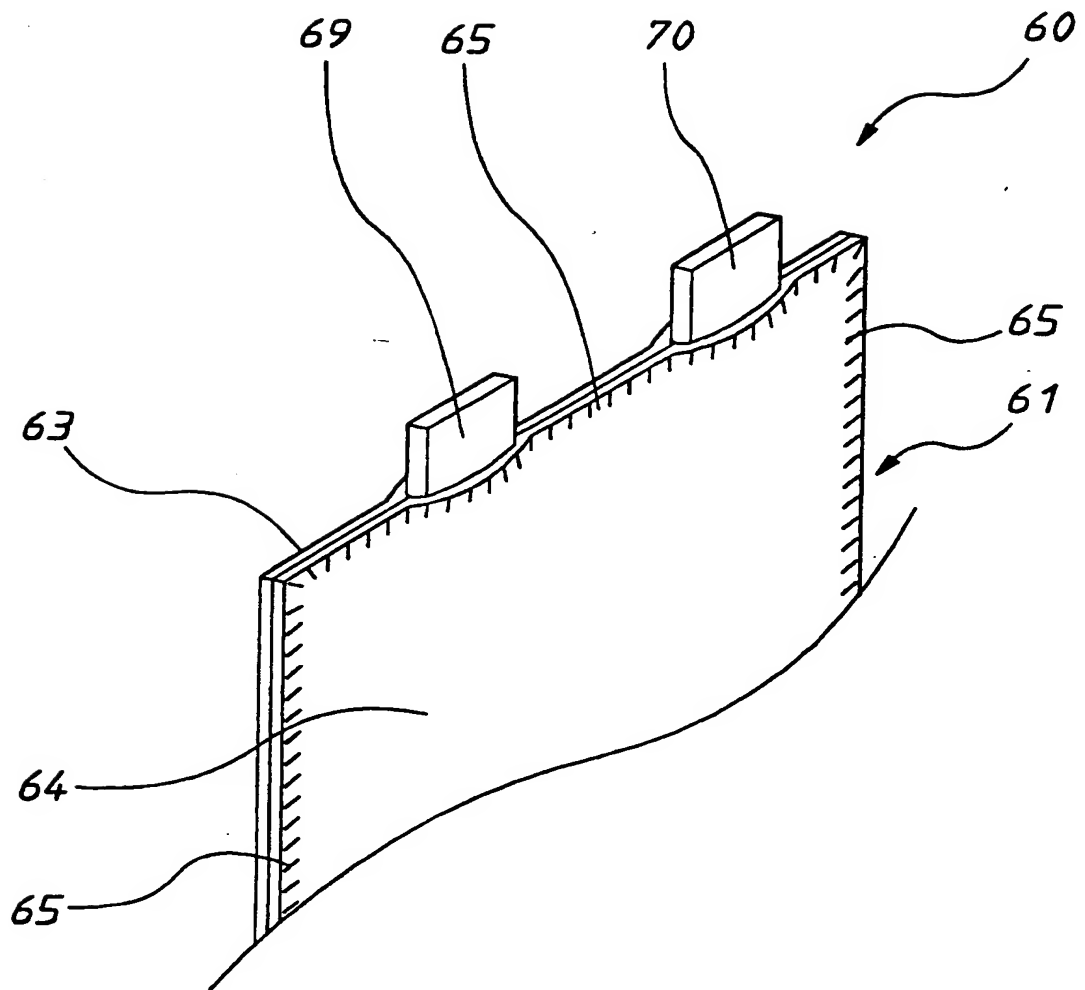


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FIG. 6

FIG. 7

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FIG. 8

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59. A method according to claim 58 wherein the separator includes two opposed separator sheets connected along at least one common edge and the method includes the further step of disposing the first electrode between the separator sheets.

60. A method according to claim 59 wherein the separator sheets are integrally formed  
5 along the common edge.

61. A method according to claim 60 wherein each separator sheet includes a first edge and a second edge spaced apart from the first, both of which extend away from the common edge.

62. A method according to claim 61 wherein each separator sheet also includes a third  
10 edge which extends between the first edge and the second edge, wherein the method includes the further step of joining together the first edges and joining together the second edges.

63. A method according to claim 62 wherein the third edges are opposed.

64. [NEW CLAIM] A charge storage device including:

15 a housing;

a first folded sheet electrode disposed within the housing and having two opposite faces;

a second sheet electrode disposed within the housing and having two opposed faces, wherein the second sheet electrode is folded about the first sheet electrode such that each  
20 opposed face is adjacent to and opposed with a respective opposite face;

a separator for enveloping substantially all of the first electrode and for maintaining the electrodes in a spaced apart configuration;

an electrolyte disposed intermediate the electrodes; and

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two terminals extending from the respective electrodes and terminating outside the housing for allowing external electrical connection to the electrodes.

65. [NEW CLAIM] A device according to claim 64 wherein the first electrode is nested within the second electrode.
- 5 66. [NEW CLAIM] A device according to claim 64 wherein the separator is a sheet that is nested between the first electrode and the second electrode.